

Network Analysis of World Trade using the BACI-CEPII dataset

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Highlights

- This paper explores the World Trade using the Network Analysis and introduces the reader to some of the techniques used to visualize, calculate and synthetically represent network trade data.
- The paper shows different visualizations of the network and describe its topological properties, producing and discussing some of the commonly used Network's statistics, and presenting some specific topics.
- All in all, this paper shows that Network Analysis is a useful tool to describe bilateral trade relations among countries when interdependence matters, and when trade relations are characterized by high dimensionality and strong heterogeneity.

Main Contents

- (1) Global Analysis – Visualization
- (2) Global Analysis – Network Statistics
- (3) Global Analysis – Centrality Analysis
- (4) Commodity-Specific Analysis – Visualization
- (5) Commodity-Specific Analysis– Centrality Analysis

(1) Global Analysis – Visualization

Figure 1 –
 Map of World Trade in Goods, 2000 (US billion dollars)



Total world trade flows in 2000: \$6,600 billion

World Trade in Goods

- < \$50 billion
- \$50–150 billion
- \$150–500 billion
- > \$500 billion

Source: Feenstra and Taylor, 2008, Chapter 1.

Figure 2 –
Map of World Trade in Goods as a Geographical Network (major two export partners,)
2007.

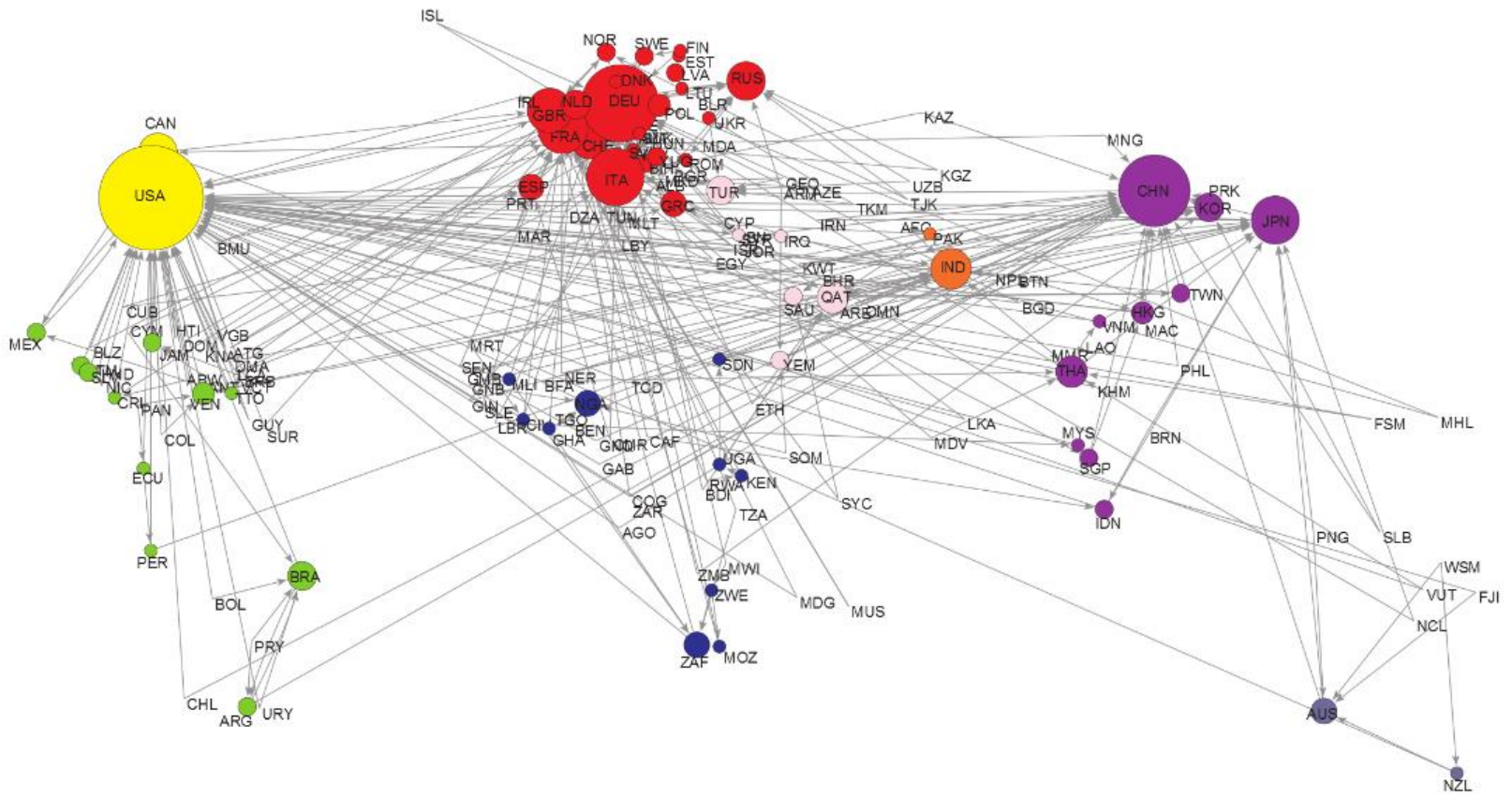


Figure 3 –
The Network of World Trade in Goods (major two export partners,) 2007.

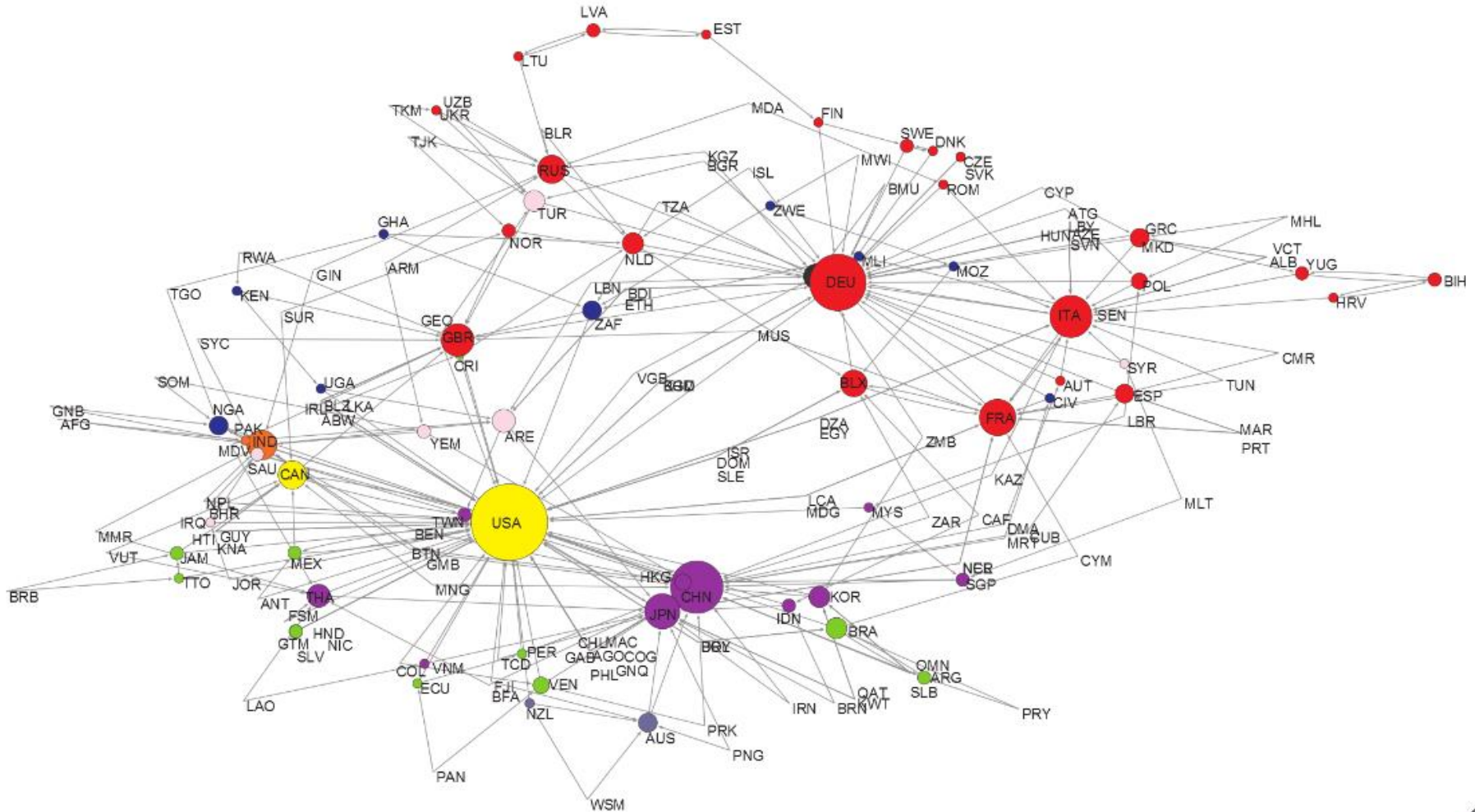
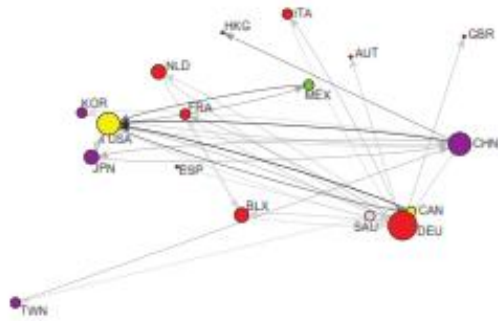
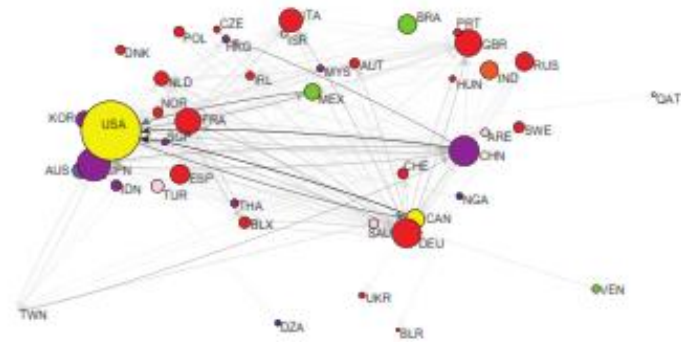


Figure 6 –
The World Trade Network in Goods, 2007.

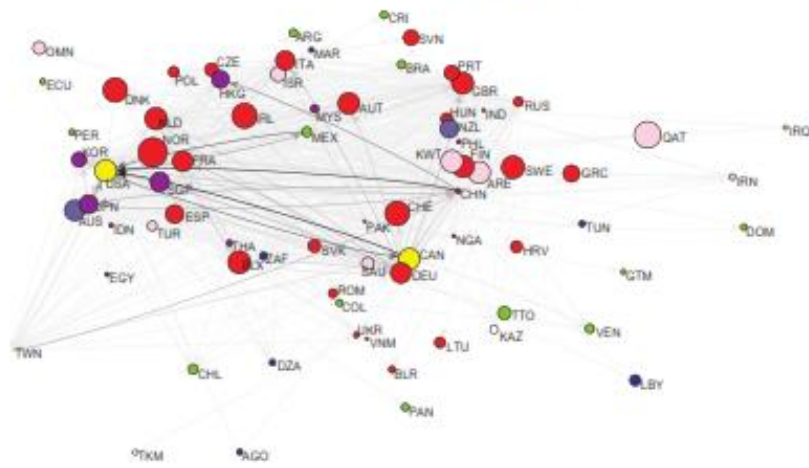
(a) 25% of world trade



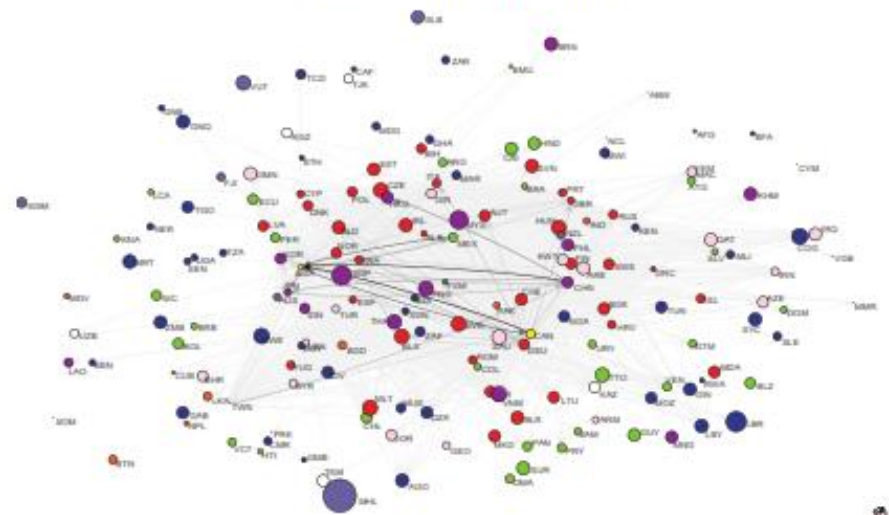
(b) 50% of world trade



(c) 75% of world trade

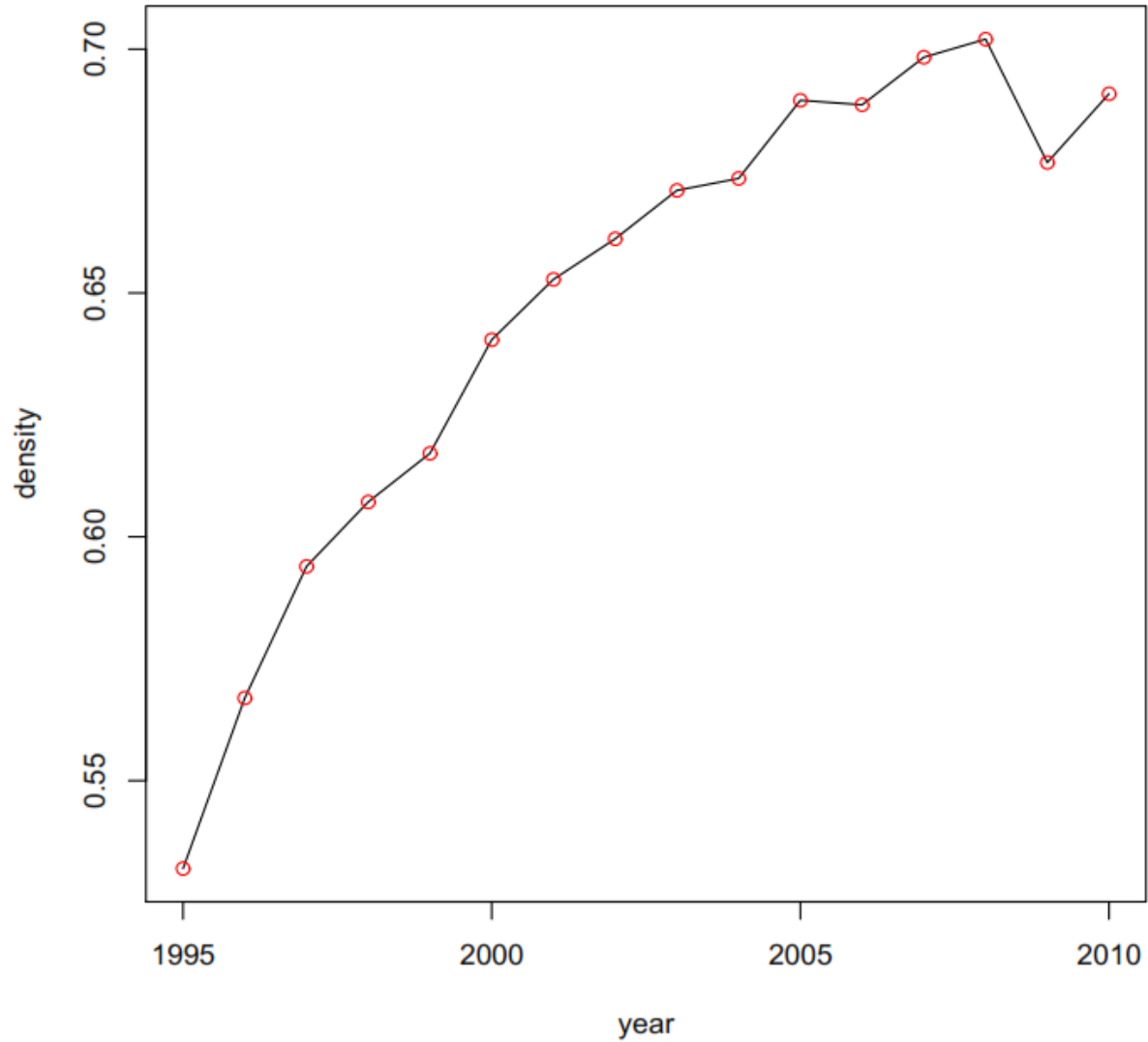


(d) 90% of world trade



(2) Global Analysis – Network Statistics

Figure 4 –
Density, 1995-2010



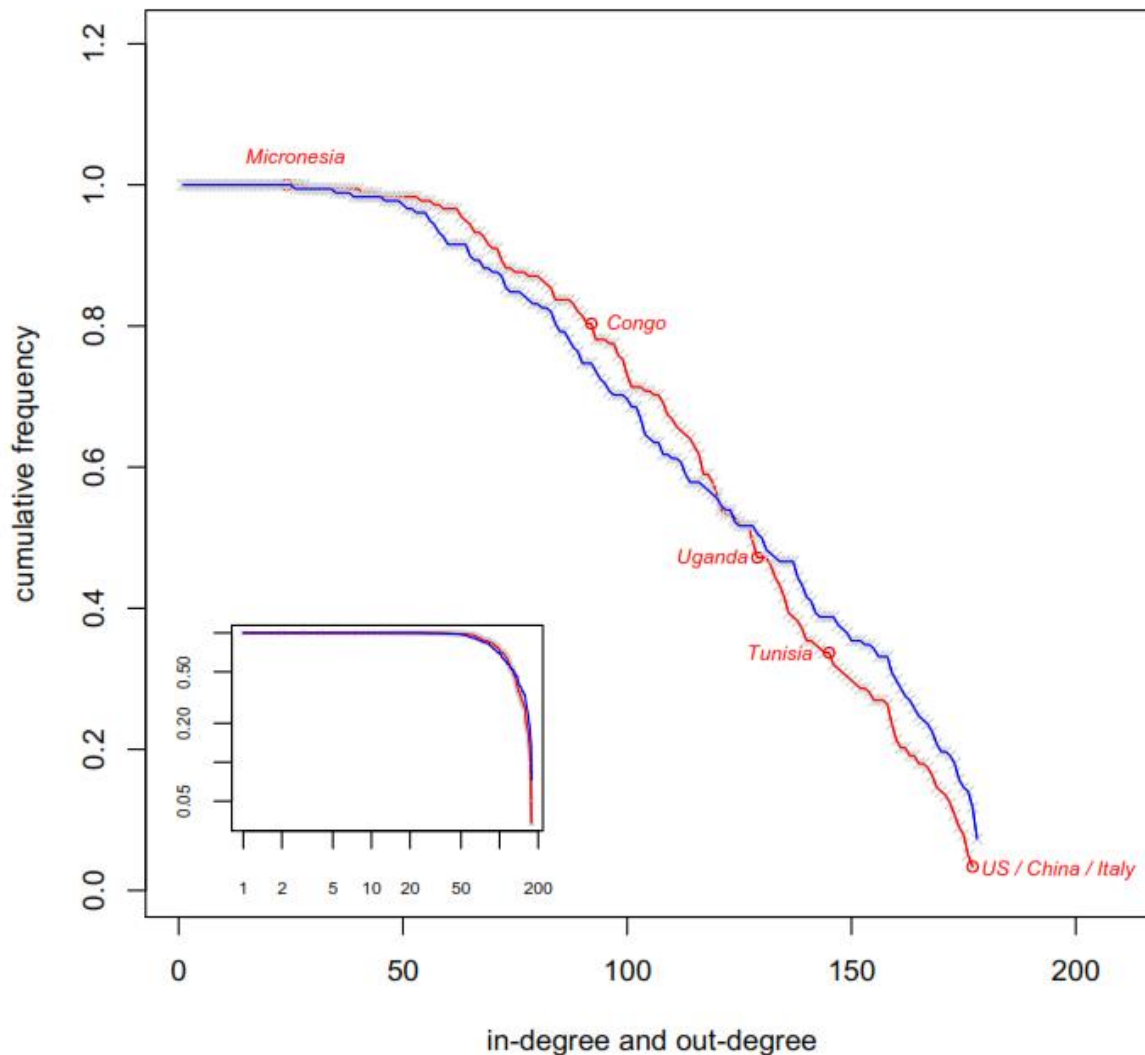
Global Analysis – Network Statistics

- If the distribution of trade flows among country-pairs (i.e. the weighted network) appears to be highly heterogeneous, similar heterogeneity is encountered also in trade partnerships (i.e. the unweighted network).
- Calling **out-degree** the number of **out-going links** originated from country i towards its trade partners (direct trade partners define the nearest neighborhood of i), and **in-degree** the number of **in-coming link** to country i , it is possible to plot the **cumulative distributions** of such degrees.

Global Analysis – Network Statistics

- The in-degree distribution is the one where some countries are identified by small circles: Italy, China and the US have the maximum possible number of in-degrees, importing from all possible countries in the database; Tunisia is importing from 132 countries; Congo from 92, and so forth.
- The out-degree distribution (with no countries identified) shows that the percentile of countries that trade with a **high number of partners** is **higher for exports than for imports**.

Figure 5 –
Countries' Out-degree and In-degree in 2007: Cumulative Distribution



Note: The whole set of trade flows has been used in calculating the in-degree (the red continuous line with circles indicating some specific countries: US/China/Italy, etc.) and out-degree (the blue line) distributions. The inset show the same data on a log-log scale. Trade data come from BACI-CEPII dataset. The distribution is drawn using R (igraph).

Global Analysis – Network Statistics

- Both distributions are **power-law** and this is even more evident when the distributions are plotted on a log-log scale as in the framed inset in Figure 5.
- Even if **most laws in economics are power-laws**, this is a crucial finding.
- Extending an argument fully explored by Gabaix(2009,2011) when the distribution of countries is **fat-tailed**, the **central limit theorem breaks down**, and idiosyncratic **shocks to heavily connected countries** explain a non-trivial fraction of **aggregate world fluctuations**.

(3) Global Analysis – Centrality Analysis

Table 1 – Centrality - unweighted measures

id	i	iso3	country	(1) Out-degree	(2) In-degree	(3) Out-degree percent	(4) In-degree percent	(5) Out-closeness	(6) In-closeness	(7) Out-eigenvector	(8) In-eigenvector
1	533	ABW	Aruba	.35593	.37288	.28634	.29997	.60825	.61458	.0396	.04252
2	4	AFG	Afghanistan	.49718	.48588	.39996	.39087	.66541	.66045	.05651	.05558
3	24	AGO	Angola	.42373	.55367	.34088	.44541	.63441	.69141	.04887	.06264
4	8	ALB	Albania	.62712	.71186	.5045	.57268	.7284	.77632	.06842	.07549
5	530	ANT	Netherlands Antilles	.53107	.46328	.42723	.37269	.68077	.65074	.05777	.05198
6	784	ARE	United Arab Emirates	.9322	.89831	.74993	.72266	.93651	.90769	.09198	.09089
7	32	ARG	Argentina	.93785	.76271	.75448	.61358	.94149	.80822	.09273	.07971
8	51	ARM	Armenia	.57627	.73446	.46359	.59086	.70238	.79018	.06265	.07706
9	28	ATG	Antigua and Barbuda	.51977	.64972	.41814	.52268	.67557	.74059	.05571	.06862
10	36	AUS	Australia	.9887	.9661	.79538	.7772	.98883	.96721	.09499	.09479
...		
169	92	VGB	Virgin Islands	.49153	.44633	.39542	.35906	.66292	.64364	.05309	.04982
170	704	VNM	Viet nam	.9209	.77966	.74084	.62722	.9267	.81944	.09161	.08121
171	548	VUT	Vanuatu	.31638	.36158	.25452	.29088	.59396	.61034	.03615	.04019
172	882	WSM	Samoa	.24859	.32203	.19998	.25907	.57097	.59596	.02909	.03725
173	887	YEM	Yemen	.59887	.66102	.48177	.53177	.71371	.74684	.06487	.07087
174	891	YUG	Serbia and Montenegro	.83616	.88701	.67267	.71357	.85922	.89848	.08553	.08965
175	711	ZAF	South Africa	.9887	.98305	.79538	.79084	.98883	.98333	.09528	.096
176	180	ZAR	Congo Dem. Rep.	.40678	.41243	.32724	.33179	.62766	.62989	.04611	.04724
177	894	ZMB	Zambia	.55932	.66667	.44996	.53631	.69412	.75	.06171	.07135
178	716	ZWE	Zimbabwe	.77966	.59887	.62722	.48177	.81944	.71371	.07986	.06467

Table 2 – Centrality - weighted measures

id	i	iso3	country	(1) Out-strength	(2) In-strength	(3) Out-strength percent	(4) In-strength percent	(5) W-Out-closeness	(6) W-In-closeness	(7) W-Out-eigenvector	(8) W-In-eigenvector
1	533	ABW	Aruba	24328.21	14732.21	.03207	.01942	.72634	.35986	.00257	.00142
2	4	AFG	Afghanistan	1880.917	20843.3	.00248	.02747	.11901	.31131	.00003	.00108
3	24	AGO	Angola	187955	68658.4	.24775	.0905	.82343	.37339	.02293	.00396
4	8	ALB	Albania	6845.41	24469.3	.00902	.03225	.48718	.34375	.00032	.00093
5	530	ANT	Netherlands Antilles	19876.57	26701.99	.0262	.0352	.46844	.37334	.00089	.00303
6	784	ARE	United Arab Emirates	788635	694503.6	1.03952	.91544	.84608	.41277	.04276	.04072
7	32	ARG	Argentina	323668.9	244444.3	.42664	.32221	.80289	.40881	.01575	.01512
8	51	ARM	Armenia	7777.557	18172.09	.01025	.02395	.23745	.28337	.00031	.0007
9	28	ATG	Antigua and Barbuda	1490.491	9677.804	.00196	.01276	.12058	.25492	.00006	.00076
10	36	AUS	Australia	823285.5	869600	1.08519	1.14624	.84254	.41627	.06398	.06164
...		
169	92	VGB	Virgin Islands	2261.846	21634.1	.00298	.02852	.17193	.36645	.0001	.00076
170	704	VNM	Vietnam	307967.3	361909.4	.40594	.47704	.82077	.41135	.02439	.0185
171	548	VUT	Vanuatu	1990.4	1511.497	.00262	.00199	.20592	.08091	.00012	.00006
172	882	WSM	Samoa	989.1105	1631.536	.0013	.00215	.1976	.09984	.00003	.00007
173	887	YEM	Yemen	40926.56	60153.24	.05395	.07929	.63469	.34658	.0028	.00314
174	891	YUG	Serbia and Montenegro	50779.54	117439.3	.06693	.1548	.6137	.37973	.00158	.00451
175	711	ZAF	South Africa	502145.9	460072.9	.66189	.60643	.81734	.40969	.03207	.02632
176	180	ZAR	Congo Dem. Rep.	11157.5	15483.54	.01471	.02041	.41192	.29855	.00084	.00055
177	894	ZMB	Zambia	34256.3	22570.01	.04515	.02975	.67041	.36212	.00138	.00061
178	716	ZWE	Zimbabwe	21609.34	18506.23	.02848	.02439	.6039	.35782	.00074	.00051

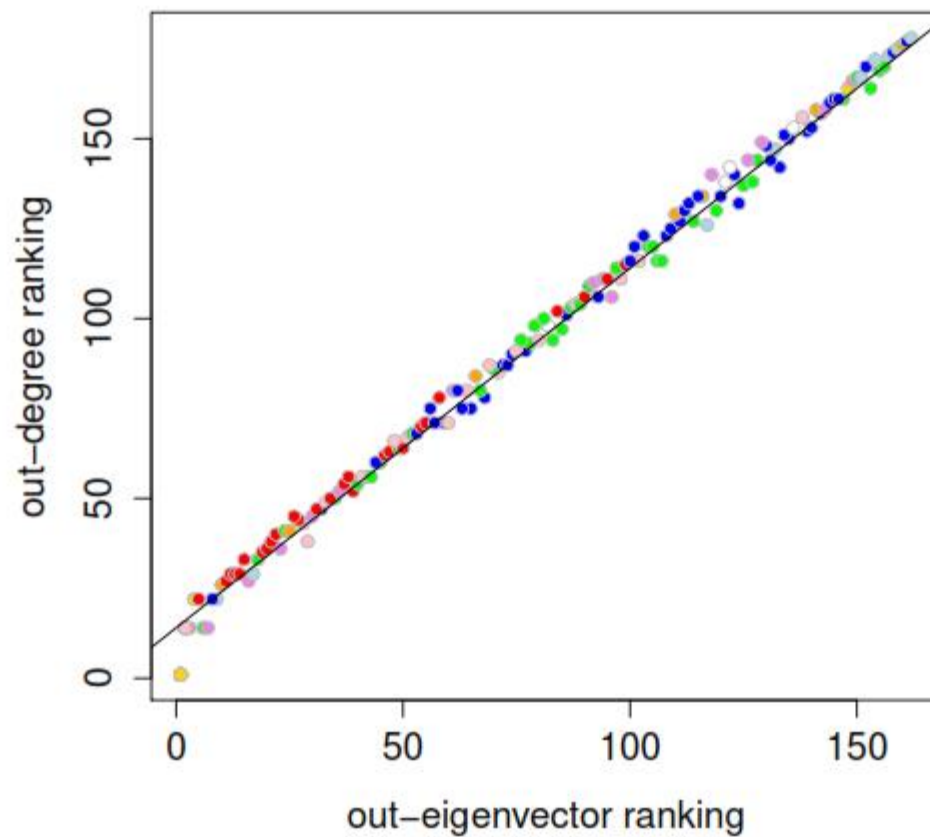
Table 3 – Centrality - unweighted measures

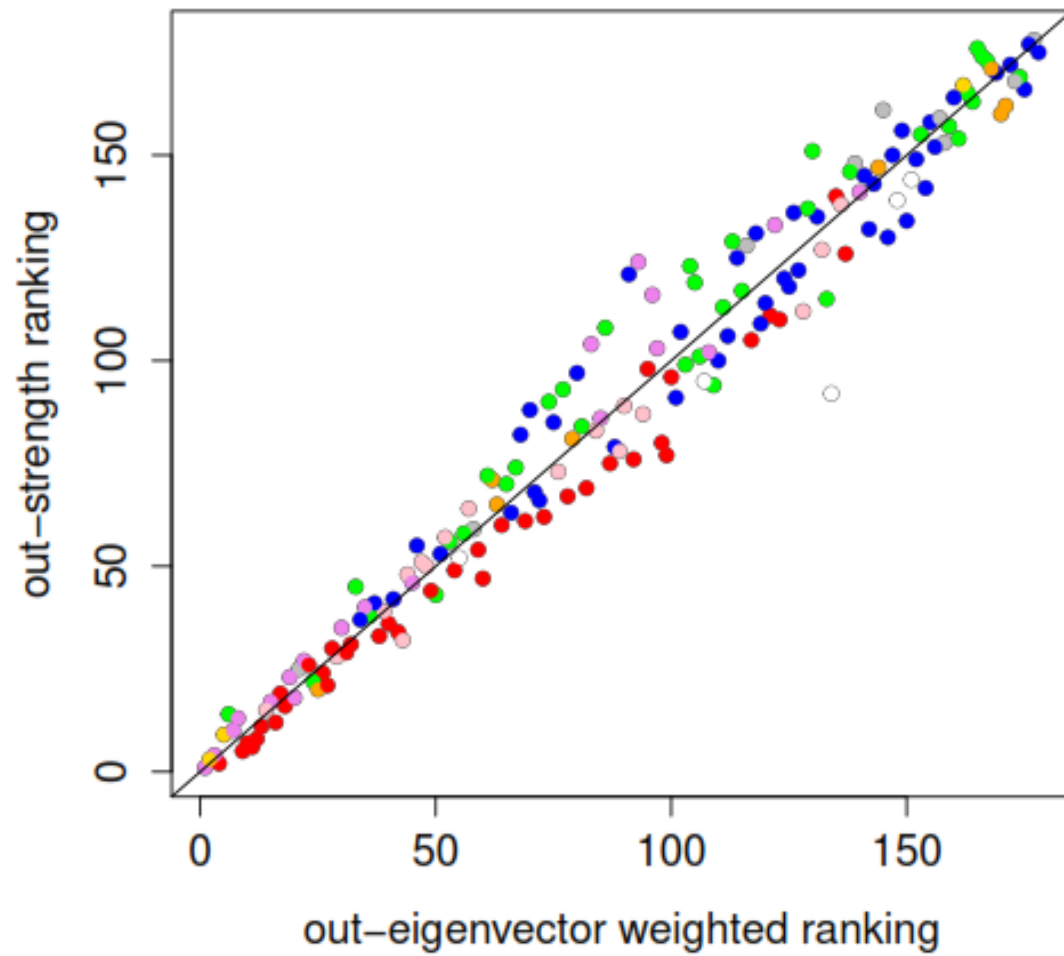
id	i	iso3	country	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Out-degree	In-degree	Out-degree percent	In-degree percent	Out-closeness	In-closeness	Out-eigenvector	In-eigenvector
10	36	AUS	Australia	3	6	3	6	3	6	9	19
11	40	AUT	Austria	1	6	1	6	1	6	1	21
16	50	BGD	Bangladesh	11	15	11	15	11	15	25	40
21	58	BLX	Belgium-Luxembourg	2	5	2	5	2	5	2	16
25	76	BRA	Brazil	2	7	2	7	2	7	6	24
30	124	CAN	Canada	3	3	3	3	3	3	4	11
32	152	CHL	Chile	21	38	21	38	21	38	45	80
33	156	CHN	China	1	2	1	2	1	2	1	6
42	203	CZE	Czech republic	7	3	7	3	7	3	15	9
45	208	DNK	Denmark	2	8	2	8	2	8	2	22
49	818	EGY	Egypt	15	24	15	24	15	24	32	54
51	233	EST	Estonia	23	46	23	46	23	46	47	100
53	246	FIN	Finland	3	14	3	14	3	14	5	34
55	251	FRA	France	1	1	1	1	1	1	1	3
43	276	DEU	Germany	1	1	1	1	1	1	1	4
65	300	GRC	Greece	9	13	9	13	9	13	20	31
72	348	HUN	Hungary	6	16	6	16	6	16	12	41
78	352	ISL	Iceland	32	41	32	41	32	41	58	85
74	699	IND	India	1	4	1	4	1	4	1	14
73	360	IDN	Indonesia	1	10	1	10	1	10	1	27
76	364	IRN	Iran	37	59	37	59	37	59	69	118
75	372	IRL	Ireland	6	5	6	5	6	5	13	17
79	376	ISR	Israel	10	17	10	17	10	17	29	47
80	381	ITA	Italy	1	1	1	1	1	1	1	1
83	392	JPN	Japan	2	3	2	3	2	3	3	13
104	484	MEX	Mexico	7	2	7	2	7	2	18	8
120	528	NLD	Netherlands	1	1	1	1	1	1	1	2
123	554	NZL	New Zealand	6	13	6	13	6	13	17	33
118	566	NGA	Nigeria	30	14	30	14	30	14	57	36
121	579	NOR	Norway	5	17	5	17	5	17	11	42
125	586	PAK	Pakistan	4	12	4	12	4	12	10	32
128	608	PHL	Philippines	9	25	9	25	9	25	23	58
130	616	POL	Poland	6	4	6	4	6	4	14	15
132	620	PRT	Portugal	8	17	8	17	8	17	19	43
136	643	RUS	Russian Federation	10	16	10	16	10	16	22	38
147	703	SVK	Slovak Republic	13	17	13	17	13	17	27	45
148	705	SVN	Slovenia	19	31	19	31	19	31	37	66
175	711	ZAF	South Africa	3	3	3	3	3	3	8	10
89	410	KOR	South Korea	2	5	2	5	2	5	7	18
50	724	ESP	Spain	2	1	2	1	2	1	2	5
149	752	SWE	Sweden	1	7	1	7	1	7	1	23
31	757	CHE	Switzerland	2	3	2	3	2	3	2	12
159	792	TUR	Turkey	2	10	2	10	2	10	2	26
165	842	USA	United States	1	2	1	2	1	2	1	7
58	826	GBR	United kingdom	1	1	1	1	1	1	1	4
170	704	VNM	Vietnam	14	31	14	31	14	31	30	63

Table 4 – Centrality - weighted measures

id	i	iso3	country	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Out-strength	In-strength	Out-strength percent	In-strength percent	W-Out-closeness	W-In-closeness	W-Out-eigenvector	W-In-eigenvector
10	36	AUS	Australia	25	22	25	22	26	25	21	19
11	40	AUT	Austria	24	23	24	23	15	14	26	20
16	50	BGD	Bangladesh	71	69	71	69	71	72	62	75
21	58	BLX	Belgium-Luxembourg	11	9	11	9	13	12	13	10
25	76	BRA	Brazil	22	29	22	29	28	28	24	25
30	124	CAN	Canada	9	12	9	12	5	2	5	2
32	152	CHL	Chile	38	47	38	47	47	51	36	43
33	156	CHN	China	1	3	1	3	1	6	1	4
42	203	CZE	Czech Republic	31	28	31	28	19	21	32	30
45	208	DNK	Denmark	33	30	33	30	39	29	38	32
49	818	EGY	Egypt	63	49	63	49	80	57	66	50
51	233	EST	Estonia	76	74	76	74	97	90	92	88
53	246	FIN	Finland	34	37	34	37	50	35	42	36
55	251	FRA	France	5	5	5	5	9	8	9	7
43	276	DEU	Germany	2	2	2	2	2	3	4	3
65	300	GRC	Greece	61	39	61	39	78	42	69	40
72	348	HUN	Hungary	36	31	36	31	30	26	40	33
78	352	ISL	Iceland	98	95	98	95	108	124	95	90
74	699	IND	India	20	17	20	17	27	27	25	21
73	360	IDN	Indonesia	27	34	27	34	29	43	22	37
76	364	IRN	Iran	39	46	39	46	41	53	39	52
75	372	IRL	Ireland	26	33	26	33	25	23	23	29
79	376	ISR	Israel	48	45	48	45	35	47	44	38
80	381	ITA	Italy	6	7	6	7	12	9	11	11
83	392	JPN	Japan	4	6	4	6	4	7	3	8
104	484	MEX	Mexico	14	14	14	14	7	4	6	6
120	528	NLD	Netherlands	8	8	8	8	11	11	12	9
123	554	NZL	New Zealand	59	56	59	56	65	58	58	54
118	566	NGA	Nigeria	41	51	41	51	22	64	37	51
121	579	NOR	Norway	30	35	30	35	33	41	28	35
125	586	PAK	Pakistan	65	53	65	53	70	63	63	59
128	608	PHL	Philippines	40	43	40	43	49	52	35	41
130	616	POL	Poland	29	20	29	20	21	17	31	22
132	620	PRT	Portugal	49	38	49	38	52	31	54	39
136	643	RUS	Russian Federation	12	18	12	18	24	18	16	18
147	703	SVK	Slovak Republic	44	44	44	44	44	38	49	47
148	705	SVN	Slovenia	60	58	60	58	63	55	64	62
175	711	ZAF	South Africa	37	36	37	36	48	44	34	34
89	410	KOR	South Korea	10	13	10	13	8	16	7	13
50	724	ESP	Spain	16	10	16	10	23	13	18	14
149	752	SWE	Sweden	21	24	21	24	38	22	27	26
31	757	CHE	Switzerland	19	19	19	19	16	15	17	17
159	792	TUR	Turkey	32	21	32	21	40	30	43	23
165	842	USA	United States	3	1	3	1	3	1	2	1
58	826	GBR	United Kingdom	7	4	7	4	10	5	10	5
170	704	VNM	Vietnam	46	42	46	42	45	37	45	42

Figure 9 –
Local and global centrality, 2007. Respectively unweighted and weighted network





(6) Commodity-Specific Analysis – Visualization

Figure 11 –
World Trade Network in Portland Cement (major two importing partners, 2007)

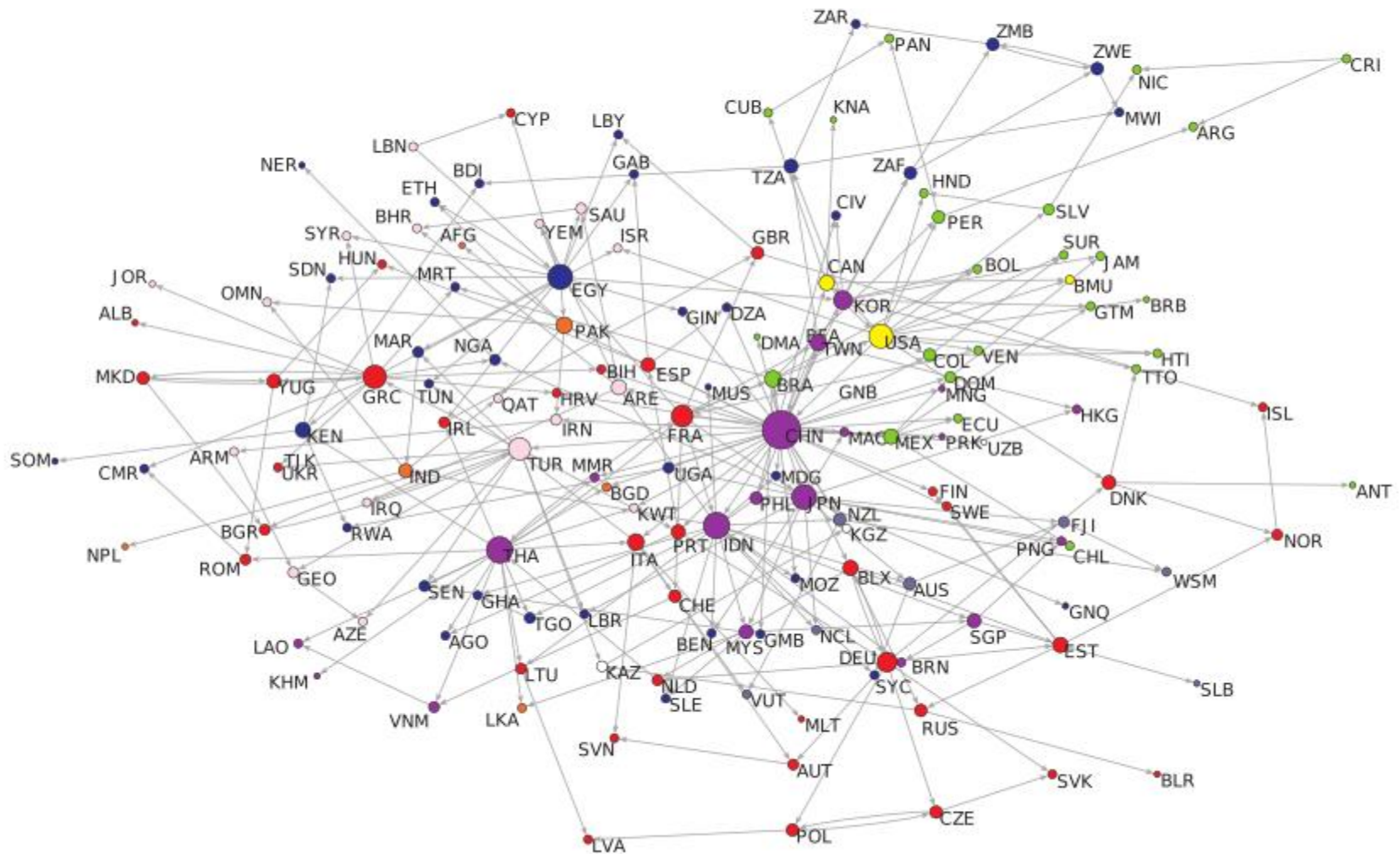


Figure 12 –
World Trade Network in Movies (major two importing partners, 2007)

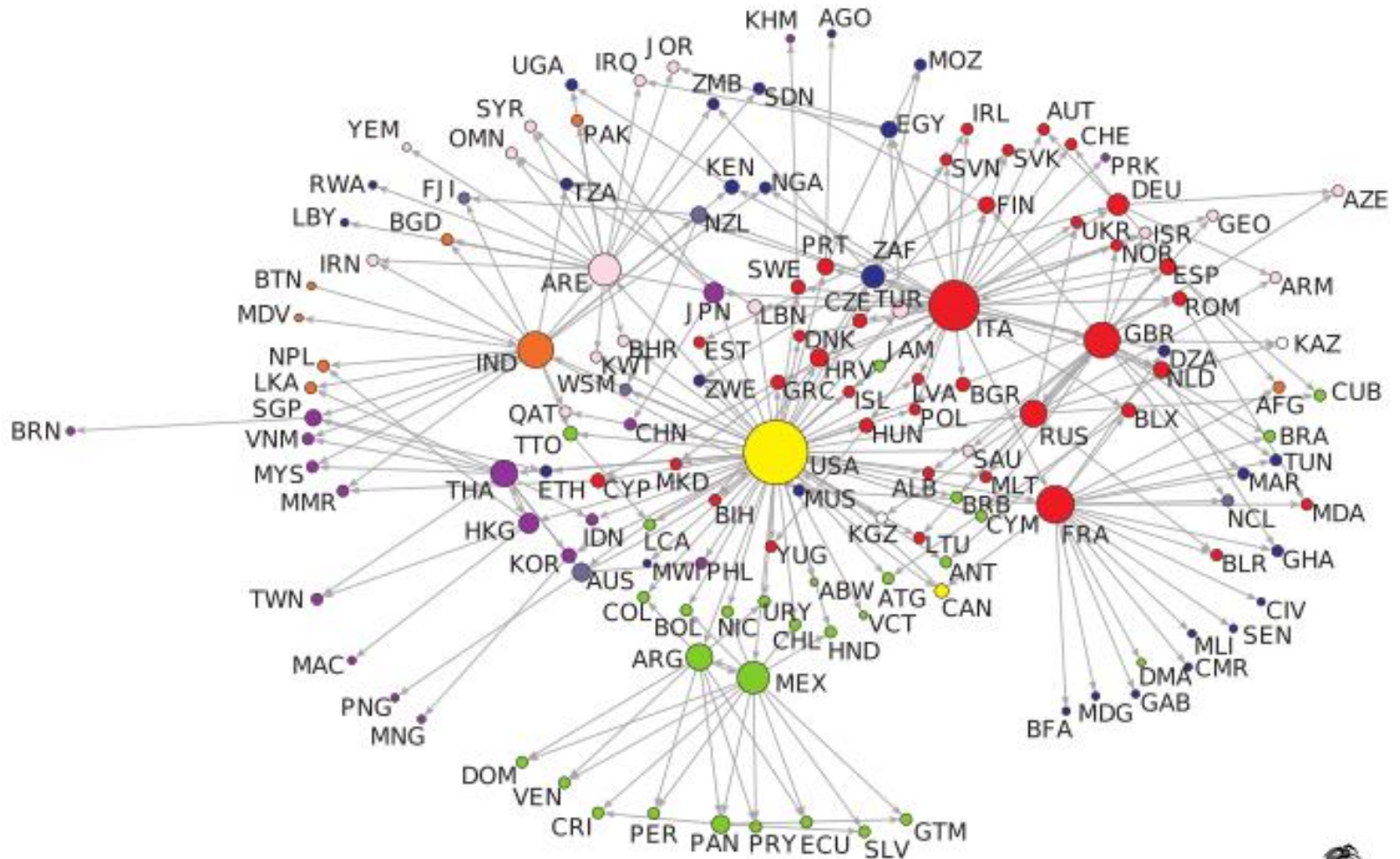


Figure 14 –
World Trade Network in Footwear (major two importing partners, 2007)

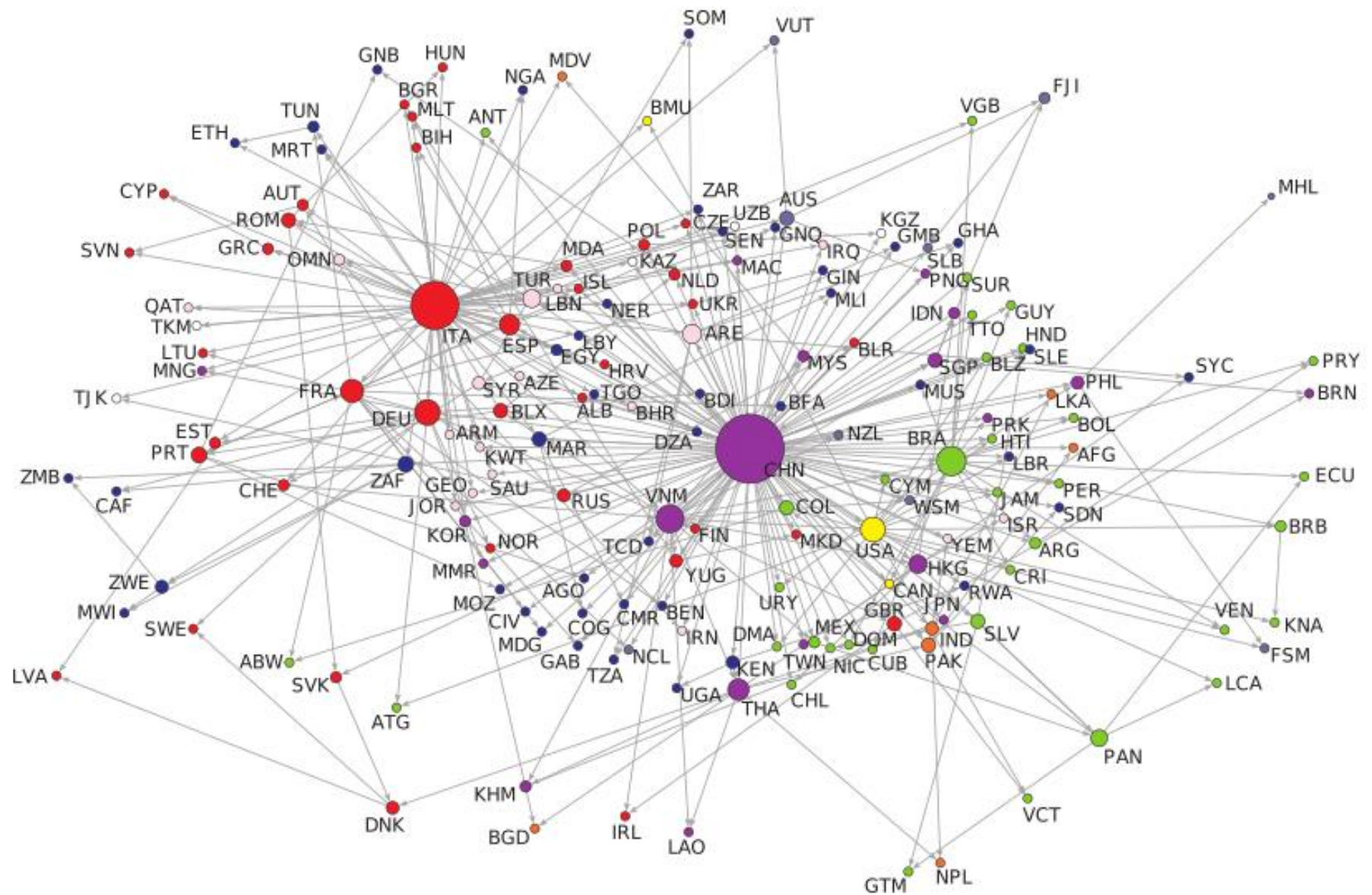
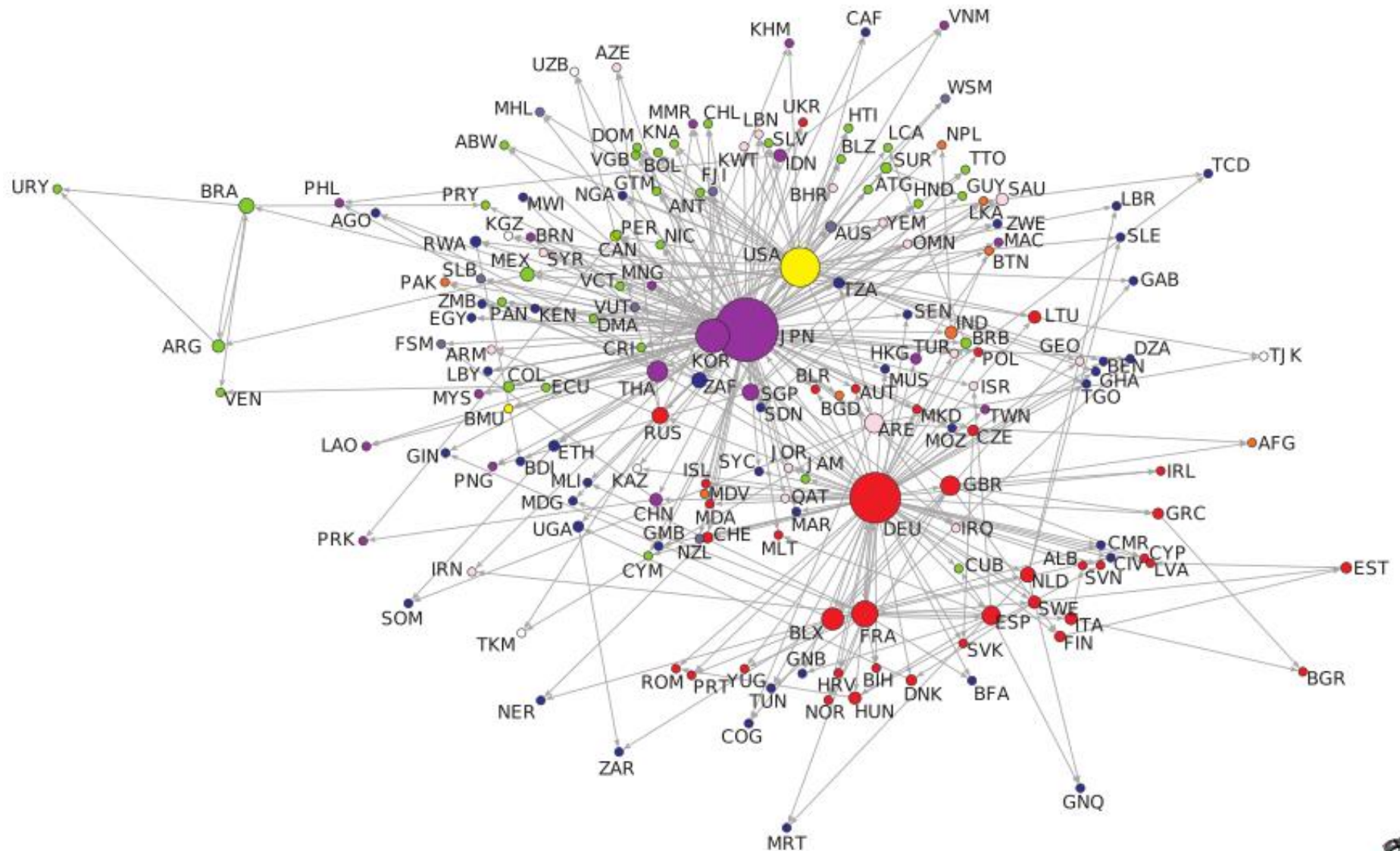


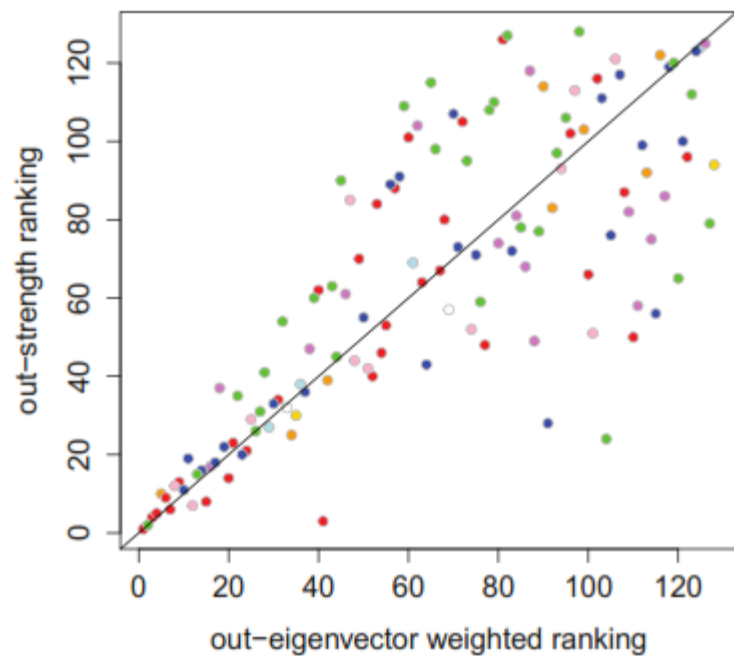
Figure 15 –
World Trade Network in Engines (major two importing partners, 2007)



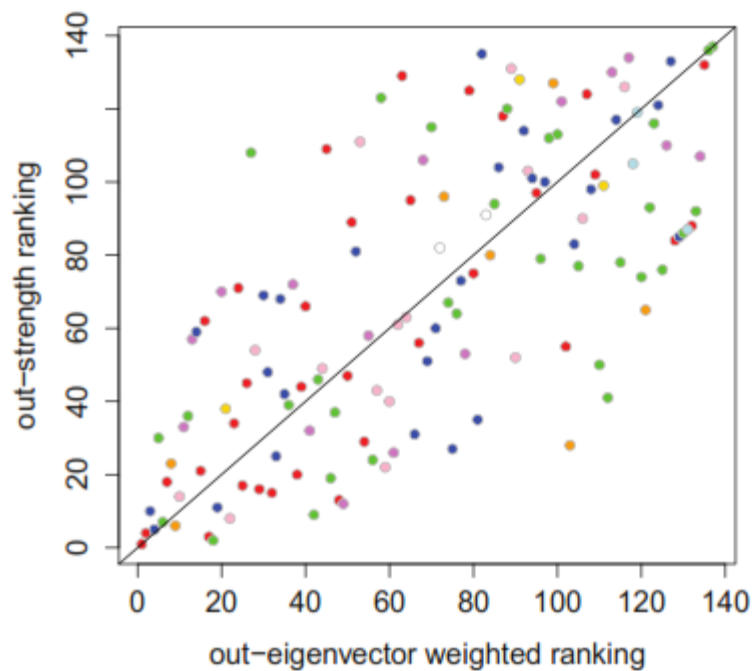
(5) Commodity-Specific Analysis— Centrality Analysis

Figure 16 –
Strength and Eigenvector centralities at the sectoral level, 2007.

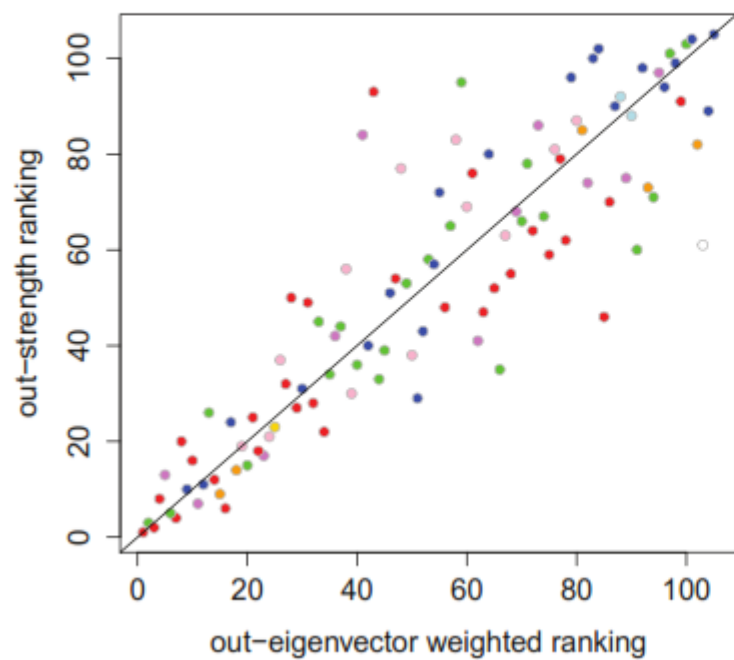
(a) Bananas



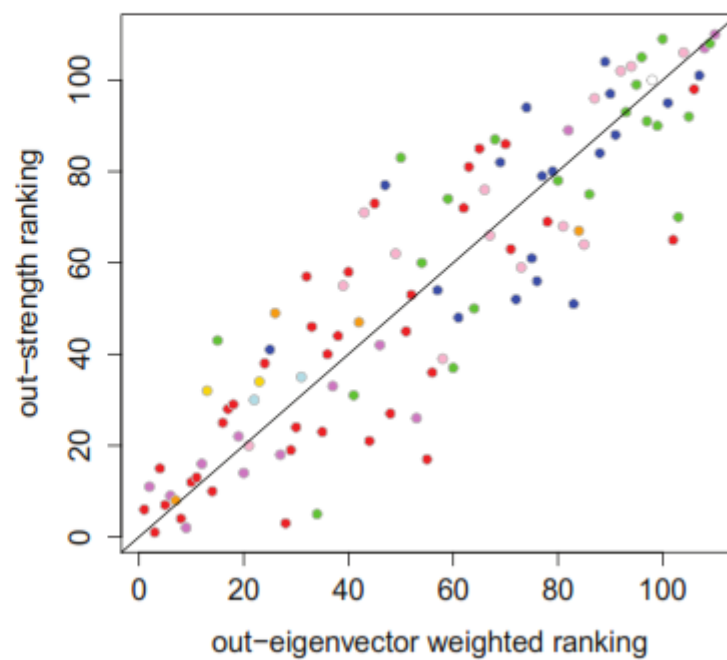
(b) Portland Cement



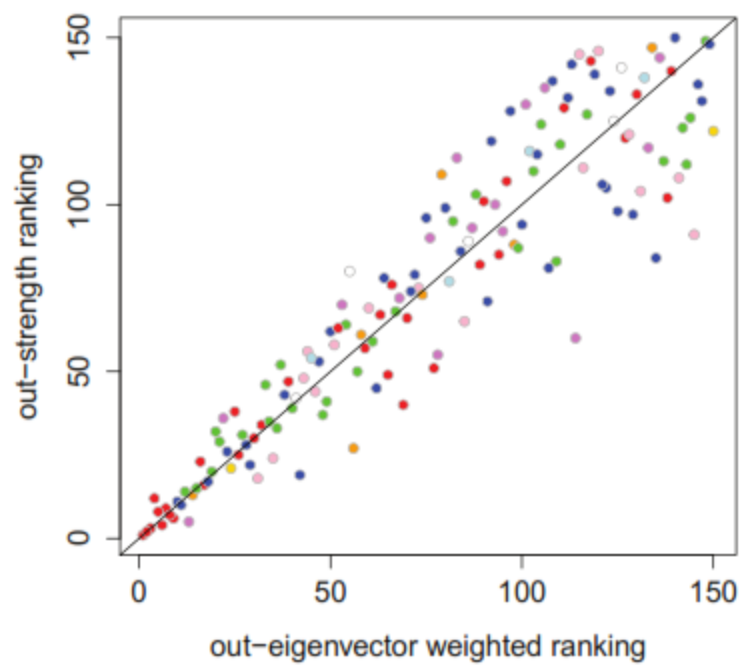
(c) Movies



(d) Crude Oil



(e) Footwear



(f) Engines

